

1 **CLAIMS:**

2 What is claimed is:

3 1. An electronic watermarking system, for embedding
4 additive information in digital data, for which one frame
5 is defined as including N samples extracted from digital
6 data and a current frame is defined as a frame that is
7 overlapped by M samples ($0 < M \leq N/2$) of a preceding frame,
8 comprising:

9 (1) a frequency domain transformation unit, for
10 multiplying a frame extracted from digital data by a
11 window function, and for using the results to perform a
12 Fourier transform and thus obtain a frequency component
13 for said digital data;

14 (2) a frequency domain embedding unit, for employing
15 bit information for additive information, and a frequency
16 band for said frequency component to change the amplitude
17 of said frequency component in said digital data obtained
18 by said frequency domain transformation unit;

19 (3) a time domain transformation unit, for
20 performing an inverse Fourier transform to return, to a
21 time domain signal, said frequency component whose
22 amplitude has been changed by said frequency domain
23 embedding unit; and

24 (4) an additive information embedding frame
25 generator, for multiplying, by a window function, said
26 time domain signal obtained by said time domain
27 transformation unit, and for superimposing overlapped

1 frames to generate a frame wherein said additive
2 information is embedded.

3 2. An electronic watermarking system according to claim
4 1, wherein, to change said amplitude of said frequency
5 component of said digital data, said frequency domain
6 embedding unit (2) employs bit information for additive
7 information and the values of a mask, determined in
8 advance in accordance with a frequency band, with which
9 said frequency component is to be increased or decreased.

10 3. An electronic watermarking system according to claim
11 2, wherein the values of said mask corresponding to all
12 the frequencies included in one frequency band are
13 equalized.

14 4. An electronic watermarking system according to claim
15 2 or 3, wherein, as the frequency increases, the width of
16 said frequency band is extended.

17 5. An electronic watermark detection system, for
18 detecting additive information embedded in digital data,
19 comprising:

20 (1) a frequency domain transformation unit, for
21 multiplying a frame extracted from digital data by a
22 window function, and for performing a Fourier transform
23 to obtain a frequency component from said digital data;

24 (2) an amplitude storing unit, for obtaining
25 amplitudes for said frequency components acquired by said
26 frequency domain transformation unit, and for storing a

1 number of said amplitudes that equals a predetermined
2 frame count;
3 (3) a cycle synchronization unit, for employing an
4 amplitude value stored by said amplitude storing unit to
5 designate a bit detection start frame; and
6 (4) a bit detector, for detecting bit information
7 from embedded additive information beginning at said bit
8 detection start frame obtained by said cycle
9 synchronization unit.

10 6. An electronic watermark detection system according to
11 claim 5, wherein said frequency domain transformation
12 unit (1) uses the shorter length of said frame than the
13 length when said additive information is embedded.

14 7. An electronic watermark detection system according to
15 claim 5, wherein, in order to designate said bit
16 detection start frame by referring to said amplitude
17 values, said cycle synchronization unit (3) employs
18 calculation results obtained by using the values of a
19 mask that defines, in advance, a frequency component
20 increase or decrease.

21 8. An electronic watermarking method, for embedding
22 additive information in digital data, whereby one frame
23 is defined as including N samples extracted from digital
24 data, and a current frame is defined as a frame that is
25 overlapped by M samples ($0 < M \leq N/2$) of a preceding frame,
26 comprising the steps of:

27 (1) extracting one frame as a current frame from

1 digital data;
2 (2) multiplying said current frame by a window
3 function;
4 (3) performing a Fourier transform for the resultant
5 current frame to obtain a frequency component for said
6 current frame;
7 (4) changing an amplitude of said frequency
8 component in accordance with bit information for additive
9 information;
10 (5) performing an inverse Fourier transform for the
11 resultant frequency component;
12 (6) multiplying, by said window function, said
13 frequency component obtained using said inverse Fourier
14 transform; and
15 (7) adding an (N-M)-th sample, from the end of a
16 preceding frame processed in the same manner as said
17 steps (1) to (6), to an M-th sample, from the head of
18 said current frame processed at said step (6), and
19 generating one new frame including N samples.

20 9. An electronic watermarking method according to claim
21 8, wherein, at said step (4) of changing said amplitude
22 of said frequency component, said amplitude is changed by
23 employing bit information for additive information and
24 the values of a mask, determined in advance in accordance
25 with a frequency band, with which said frequency
26 component is to be increased or decreased.

27 10. An electronic watermarking method according to claim
28 9, wherein the values of said mask corresponding to all

1 the frequencies included in one frequency band are
2 equalized.

3 11. An electronic watermarking method according to claim
4 9 or 10, wherein, as the frequency increases, the width
5 of said frequency band is extended.

6 12. A method for detecting additive information embedded
7 in digital data comprising the steps of:

8 (1) extracting one frame including N samples from
9 digital data;

10 (2) multiplying said frame by a predetermined window
11 function;

12 (3) performing a Fourier transform for said
13 resultant frame to obtain a frequency component of said
14 frame;

15 (4) storing a value for an amplitude of said
16 frequency component;

17 (5) calculating an optimal start frame for additive
18 information detection when the stored amplitude value
19 reaches a predetermined value through said steps (1) to
20 (4); and

21 (6) detecting bit information for said additive
22 information beginning at said start frame.

23 13. A method according to claim 12, wherein, at said
24 step (1) of extracting one frame, uses the shorter length
25 of said frame than the length when said additive
26 information is embedded.

1 14. A method according to claim 12, wherein, at said
2 step (5) of calculating the optimal start frame,
3 calculation results obtained by using the values of a
4 mask, which define, in advance, a frequency component
5 increase or decrease, are employed in order to designate
6 said bit detection start frame by referring to said
7 amplitude value.

8 15. An electronic watermarking method for embedding in
9 digital data N bits ($N \geq 1$) of additive information
10 comprising the steps of:
11 (1) reading sample values, from digital data, up to
12 an R -th sample ($R \geq 1$);
13 (2) reading sample values, from said digital data,
14 following an $(R+1)$ -th sample;
15 (3) changing said sample values following said
16 $(R+1)$ -th sample in accordance with bit information for
17 additive information; and
18 (4) adding together the values up to said R -th
19 sample in said digital data and the values following said
20 $(R+1)$ -th sample, changed in accordance with said bit
21 information for said additive information.

22 16. An electronic watermarking method for embedding in
23 digital data N bits ($N \geq 1$) of additive information
24 comprising the steps of:
25 (1) reading a sample value from digital data;
26 (2) starting to change said sample value in
27 accordance with bit information for additive information,

1 excluding a head bit of said additive information; and
2 (3) using said changed sample value to generate new
3 digital data.

4 17. An electronic watermarking method for embedding in
5 digital data N bits ($N \geq 1$) of additive information
6 comprising the steps of:

7 (1) reading a sample value from digital data;
8 (2) changing said sample value in accordance with
9 bit information for additive information;
10 (3) adding noise at random to said changed sample
11 value; and
12 (4) using said changed sample value to generate new
13 digital data.

14 18. An electronic watermarking method for embedding in
15 digital data N bits ($N \geq 1$) of additive information
16 comprising the steps of:

17 (1) reading a sample value from digital data;
18 (2) changing said sample value in accordance with
19 bit information for additive information, and setting at
20 random a case wherein a change is not required; and
21 (3) using either the changed sample value or the
22 unchanged sample value to generate new digital data.

23 19. An electronic watermarking method for embedding in
24 digital data N bits ($N \geq 1$) of additive information
25 comprising the steps of:

26 (1) changing digital data by superimposing,

1 inserting, deleting or shifting a specific sample of said
2 digital data;
3 (2) reading a sample value from said digital data;
4 (3) changing said sample value in accordance with
5 bit information for additive information; and
6 (4) using said changed sample value to generate new
7 digital data.

8 20. An electronic watermarking method for embedding in
9 digital data N bits ($N \geq 1$) of additive information
10 comprising the steps of:
11 (1) expanding or compressing digital data along a
12 time axis;
13 (2) reading a sample value from said digital data;
14 (3) changing said sample value in accordance with
15 bit information for additive information; and
16 (4) using said changed sample value to generate new
17 digital data.

18 21. An electronic watermarking method for embedding in
19 digital data N bits ($N \geq 1$) of additive information
20 comprising the steps of:
21 (1) reading a sample value from said digital data;
22 (2) changing said sample value in accordance with
23 bit information for additive information;
24 (3) using said changed sample value to generate new
25 digital data; and
26 (4) expanding or compressing said new digital data
27 along a time axis.

1 22. An electronic watermarking method according to claim
2 20 or 21, wherein an expansion/compression rate for the
3 digital data does not exceed 1%.

4 23. An electronic watermarking method for embedding in
5 digital data N bits ($N \geq 1$) of additive information
6 comprising the steps of:

7 (1) re-sampling digital data at a sampling frequency
8 r' and reading a sample value from said digital data;

9 (2) changing said sample value in accordance with
10 bit information for additive information; and

11 (3) sampling said changed sample value at the
12 original sampling frequency r to generate new digital
13 data.

14 24. An electronic watermarking method for embedding in
15 digital data N bits ($N \geq 1$) of additive information
16 comprising the steps of:

17 (1) sampling digital data at a sampling frequency r'
18 and reading a sample value from said digital data;

19 (2) obtaining a change in said sample value in
20 accordance with bit information for additive information;

21 (3) re-sampling said change at a sampling frequency
22 r for the original digital data; and

23 (4) adding said re-sampled change to said original
24 digital data to generate new digital data.

25 25. A computer-readable recording medium on which a
26 program for embedding additive information in digital
27 data is stored, said program defining one frame as

1 including N samples extracted from digital data and
2 defining a current frame as a frame that is overlapped by
3 M samples ($0 < M \leq N/2$) of a preceding frame, and permitting
4 a computer to execute:

5 (1) a frequency domain transformation function, for
6 multiplying a frame extracted from digital data by a
7 window function, and for using the results to perform a
8 Fourier transform and thus obtain a frequency component
9 for said digital data;

10 (2) a frequency domain embedding function, for
11 employing bit information for additive information, and a
12 frequency band for said frequency component to change the
13 amplitude of said frequency component in said digital
14 data obtained by said frequency domain transformation
15 function;

16 (3) a time domain transformation function, for
17 performing an inverse Fourier transform to return, to a
18 time domain signal, said frequency component whose
19 amplitude has been changed by said frequency domain
20 embedding function; and

21 (4) an additive information embedding frame
22 generation function, for multiplying, by a window
23 function, said time domain signal obtained by said time
24 domain transformation function, and for superimposing
25 overlapped frames to generate a frame wherein said
26 additive information is embedded.

27 26. A computer-readable recording medium on which a
28 program for detecting additive information embedded in
29 digital data is stored, said program permitting a

1 computer to execute:

2 (1) a frequency domain transformation function, for
3 multiplying a frame extracted from digital data by a
4 window function, and for performing a Fourier transform
5 to obtain a frequency component from said digital data;

6 (2) an amplitude storing function, for obtaining
7 amplitudes for said frequency components acquired by said
8 frequency domain transformation function, and for storing
9 a number of said amplitudes that equals a predetermined
10 frame count;

11 (3) a cycle synchronization function, for employing
12 an amplitude value stored by said amplitude storing
13 function to designate a bit detection start frame; and

14 (4) a bit detection function, for detecting bit
15 information from embedded additive information beginning
16 at said bit detection start frame obtained by said cycle
17 synchronization function.

18 27. An article of manufacture comprising a computer
19 usable medium having computer readable program code means
20 embodied therein for causing detection of additive
21 information embedded into digital data, the computer
22 readable program code means in said article of
23 manufacture comprising computer readable program code
24 means for causing a computer to effect the steps of claim
25 12.

26 28. An electronic watermarking system for embedding
27 additive information into digital data, said system
28 comprising:

1
2 a frequency domain transformation unit for
3 multiplying a current frame extracted from said digital
4 data by a window function, and for using the results of
5 the multiplication to obtain a frequency component for
6 said digital data, wherein a frame in said system is
7 defined as including a plurality of samples extracted
8 from the digital data, and a current frame in said system
9 is defined as a frame that is overlapped by at least one
10 sample from said plurality of samples of a preceding
11 frame;

12 a frequency domain embedding unit for employing bit
13 information for additive information, and for employing a
14 frequency band for said frequency component in changing
15 the amplitude of said frequency component in said digital
16 data obtained by said frequency domain transformation
17 unit;

18 a time domain transformation unit for performing an
19 inverse transform to return said frequency component
20 whose amplitude has been changed by said frequency domain
21 embedding unit to a time domain signal; and

22 an additive information embedding frame generator
23 for multiplying said time domain signal obtained by said
24 time domain transformation unit by the window function,
25 and for superimposing overlapped frames to generate a
26 frame wherein said additive information is embedded.

27 29. An electronic watermarking system according to claim
28 1, wherein in changing said amplitude of said frequency
29 component of said digital data, said frequency domain

1 embedding unit employs bit information for additive
2 information and the values of a mask determined in
3 advance in accordance with a frequency band.

4 30. An electronic watermarking system according to claim
5 29, wherein the values of said mask corresponding to
6 frequencies included in one frequency band are equalized.

7 31. An electronic watermark detection system comprising:

8 a frequency domain transformation unit for
9 multiplying a frame extracted from digital data by a
10 window function, and for performing a transform to obtain
11 a frequency component from said digital data, said system
12 for detecting additive information embedded in the
13 digital data;

14 (2) an amplitude storing unit for obtaining
15 amplitudes for said frequency components acquired by said
16 frequency domain transformation unit, and for storing a
17 number of said amplitudes that equals a predetermined
18 frame count;

19 (3) a cycle synchronization unit for employing an
20 amplitude value stored by said amplitude storing unit to
21 designate a bit detection start frame; and

22 (4) a bit detector, for detecting bit information
23 from embedded additive information beginning at said bit
24 detection start frame obtained by said cycle
25 synchronization unit.

26 32. An electronic watermark detection system according

1 to claim 31, wherein said frequency domain transformation
2 unit (1) uses the shorter length of said frame than the
3 length when said additive information is embedded.

4 33. An electronic watermarking method for embedding
5 additive information into digital data, said method
6 comprising:

7 defining a frame as including a plurality of samples
8 extracted from the digital data;

9 defining a current frame as a frame that is
10 overlapped by at least one of said plurality of samples
11 of a preceding frame;

12 extracting one frame as a current frame from digital
13 data;

14 multiplying said current frame by a window function;

15 performing a transform for the resultant current
16 frame to obtain a frequency component for said current
17 frame;

18 changing an amplitude of said frequency component in
19 accordance with bit information for additive information;

20 performing an inverse transform for the resultant
21 frequency component;

22 multiplying, by said window function, said frequency
23 component obtained using said inverse transform;

24 adding an additional sample, from the end of a
25 preceding frame processed in the same manner as in said
26 steps of extracting, multiplying, performing, changing,

1 performing and multiplying to a previous sample from the
2 head of said current frame processed at said step of
3 multiplying, and;
4 generating one new frame including the plurality of
5 samples.

6 34. An article of manufacture comprising a computer
7 usable medium having computer readable program code means
8 embodied therein for causing additive information to be
9 embedded into digital data, the computer readable program
10 code means in said article of manufacture comprising
11 computer readable program code means for causing a
12 computer to effect the steps of claim 33.

13 35. A method for detecting additive information embedded
14 in digital data comprising the steps of:
15 extracting one frame including a plurality of
16 samples from the digital data;
17 multiplying said one frame by a predetermined window
18 function to obtain a resultant frame;
19 performing a transform for said resultant frame to
20 obtain a frequency component of said resultant frame;
21 storing a value for an amplitude of said frequency
22 component;
23 calculating an optimal start frame for additive
24 information detection when the stored amplitude value
25 reaches a predetermined value through said steps of
26 extracting, multiplying, performing and storing; and
27 detecting bit information for said additive
28 information beginning at said start frame.

1 36. An article of manufacture comprising a computer
2 usable medium having computer readable program code means
3 embodied therein for causing additive information to be
4 embedded into digital data, the computer readable program
5 code means in said article of manufacture comprising
6 computer readable program code means for causing a
7 computer to effect the steps of claim 35.

8 37. An article of manufacture comprising a computer
9 usable medium having computer readable program code means
10 embodied therein for causing additive information to be
11 embedded into digital data, the computer readable program
12 code means in said article of manufacture comprising
13 computer readable program code means for causing a
14 computer to effect the steps of claim 8.

15 38. A computer program product comprising a computer
16 usable medium having computer readable program code means
17 embodied therein for causing additive information to be
18 embedded into digital data, the computer readable program
19 code means in said computer program product comprising
20 computer readable program code means for causing a
21 computer to effect the functions of the system in claim
22 1.

23 39. A computer program product comprising a computer
24 usable medium having computer readable program code means
25 embodied therein for causing detection of additive
26 information embedded into digital data, the computer

1 readable program code means in said computer program
2 product comprising computer readable program code means
3 for causing a computer to effect the functions of the
4 system in claim 5.